



TITLE:

Measurement of Viscosity of Liquid Air

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chanical amplitude— voltage curve at 600 c.p.s. showed a saturating tendency, also indicating over-damping.

Though we can select a proper matched damper, the power we can convert by this device is limited by the following reasons. As the Hg-solution interface forms an electrode at which electrolysis occurs by an anodic polarization as small as about +0.5 V., the approved range of alternating voltage is limited by this value. For instance, in case of the element used here, it must be smaller than about 17 V. If we enhance it by increasing the number of interfaces, the increase of the inner impedance limits the power fed to this element. Moreover, the increase of the stiffness of the piston also promotes the energy loss and the efficiency decreases.

For all the defects described, we could use this for radio-receiving. When we attached the element to a speaker-cone of rad. 5 inches and connected the electrodes to the plate of the last stage valve of a radio-receiving set and earth, we could barely catch the broadcasting. The music and speech could be understood.

(2) U-effect I. A glass filter was dipped in water and two rings of Cu-wire placed to both sides of the filter served as electrodes. In this case the mechanical amplitude of vibration produced by the application of alternating voltage was not measured and only the sound produced was heard by ears. The higher the frequency (in the range used here) and the finer the porosity of the filter, the higher the efficiency was. The finest porosity we used was No. 4, in which case we could hear the sound of frequency from 800 to 6,000 c.p.s. When the distances from the electrodes to the filter were reduced, the sound became larger, and when H_2SO_4 aq. was added to water, the sound died out.

Though the detailed examination of this effect was not performed and we could not determine the equation of this effect, we can decide from above this effect to be due to the so-called electro-osmosis. It is also expected that this can be applied to the generator of a supersonic wave, because the higher the frequency the larger the sonic wave was in the region used. We are now performing an experiment using as high a frequency as some ten thousand c. p. s.

The sensitivity of radio-receiving was larger and the fidelity was better in this case than in the former device (1).

17. Measurement of Viscosity of Liquid Air

Toshio NAIKI, Tetsuya HANAI and Sakae SHIMIZU

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By observing the damping of the free rotating oscillation of a brass

cylinder with cone-shaped ends in a cylindrical vessel filled with the fluid, we measured an accurate value of the viscosity of liquid air.

Since the mathematical treatment of such system seems to be very difficult, we derived the formula giving the viscosity from the similar procedure to that given by D. Coster (*Phil. Mag*, 37, 587 (1919)) and obtained the following expression:

$$\eta = \left[\frac{1}{2} \delta a \left(\frac{\rho \pi}{T} \right)^{\frac{1}{2}} \left(\frac{1}{2\delta} + \frac{1}{8\pi} \right) \left\{ \left(1 + \frac{2I}{l \delta a^4 \pi^2 \left(\frac{1}{2\delta} + \frac{1}{8\pi} \right)^2} \right)^{\frac{1}{2}} - 1 \right\} \right]^2,$$

where η is the coefficient of viscosity, δ and T are a logarithmic decrement and a period of the rotating oscillation respectively, a and I are the radius and the moment of inertia of the oscillating cylinder respectively, l is a corresponding length of the rotor assumed as a perfect cylinder, and ρ is the density of the fluid.

In the present experiment, we found that the logarithmic decrement decreased and its decreasing rate became larger with the fading of amplitudes. Moreover, it was ascertained that curves of δ plotted against amplitudes were only displaced in the direction of δ -axis for the other fluids with different values of the viscosity or dynamic viscosity. This important fact suggests that this phenomenon should be ascribed to the other factors than the fluid itself in spite of the common conception that the variation of δ with amplitudes due to the occurrence of the turbulent flow or vortex flow and others caused by intrinsic properties of the fluid. Then we assumed that the term concerning the resistive force can be splitted into two independent parts, the one is a force depending on amplitudes and the other is not. Therefore, the resulting logarithmic decrement δ is assumed to be composed of two parts, δ_1 and δ_2 , where δ_1 is a inherent resistive force of the apparatus and δ_2 is an usual one depending upon the fluid. From this point of view we carried out the entire treatment of measured values. At first, we obtained the corresponding length of the oscillating cylinder by the method of successive approximation using air and distilled water.

Taking into account various precautions mentioned above we obtained an accurate value of the viscosity of liquid air as follows:

$$\eta = (0.00227 \pm 0.00005) \text{ poises at } -187.3^\circ\text{C.}$$

In the following table the present value is compared with other values which have been obtained for the viscosity of liquid air.

Workers	η (poises)	Method
Verschaffelt and Nicaise	0.001858 at -183.48°C	Oscillatory rotation of a sphere ^{b)}

Forsch	0.0033	Capillary ²⁾
Authors	0.00227 \pm 0.00005 at -187.3°C	Oscillatory rotation of a cylinder

1) J. E. Verschaffelt and Ch. Nicaise, *Comm. Leiden*: No. 151, 35 (1917).

2) C. Forsch: *Phys. Zeitschr.* 1, 177 (1900).

Details of this work will be reported elsewhere in the near future.

18. High Frequency Titration. (III)

Induction Period in the Gold Sol Formation

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The reaction of gold sol formation was studied by the high frequency titration method. On tracing the reduction process of hydrochloroauric acid with hydrogen peroxide, it was necessary to examine the correlation of titrimer reading to the concentration of hydrochloroauric acid. Accordingly, the deflection of microammeter of the titrimer was preliminarily observed, when the solution of 1 % hydrochloroauric acid was drop by drop added to 125 ml. of distilled water.

The rate of change in the meter reading was nearly constant until 2 ml. of the added acid solution (the total concentration of mixed solution corresponding to 0.015 %), but when larger volume of the acid solution was dropped in, the corresponding rate of change became much smaller than before and in case of the concentration higher than 0.028 %, it was difficult to detect any change in the reduction process by the present titrimer.

The effect of the high frequency field on the gold sol formation was also observed, but for a while this effect was left out of consideration.

The sample solution used is as follows,

Hydrochloroauric acid solution	0.125-0.7 %	5 ml.
Potato starch	1.5 %	13 ml.
Distilled water		112 ml.
Hydrogen peroxide	5 -33 vol %	5 ml.

The traced curves of the reduction process are shown in the figure. At the point A, the yellow color of hydrochloroauric acid almost disappeared and the deflection of microammeter became large, then in many cases the solution colored deeply at the point B, and the reaction finished at the point C. In the less diluted Au-solution or with the more concentrated hydrogen peroxide solution, the curves became much steeper (as shown in the dotted curve) and the time interval between the initial point of the reaction and the point A became shorter.